HOSPITAL STRATEGIC MANAGEMENT BY GIS SPATIAL TECHNOLOGY OF PATIENTS ATTENDING A PRIVATE HEALTH SECTOR

Dr Sunil Kumar D, Dr Sathish Raju Nilakantam, Dr Deepak Anil, Dr M R Narayana Murthy

Abstract

Introduction: Public health care is an early adopter of geospatial technologies, the use in the private sector has grown substantially in the last decade. Technology and health care go hand in hand.

Methods: The present descriptive cross-sectional study was conducted for three years from January 2018 to December 2020 among patients attending a tertiary care hospital situated in the Mysuru district of southern Karnataka, India.

Results: On comparing the total patients during the pre-Covid and Covid impacted period, there was an average reduction of 32.14% cases (16744 patients) in the year 2020. The Covid-19 impacted period of 2020 saw a massive fall of patients visiting the outpatient department from 9,27,171 in 2018 and 10,12,545 in 2010 to 4,83,162, i.e., an almost 49.89% reduction.

Conclusions: GIS enables hospitals and health systems to develop location-based population health strategies and insight that goes deeper than simply what happens inside of a hospital or doctor's office.

Keywords

Public health, geospatial technologies, tertiary care hospital, outpatient department, health system

Introduction

Public health care is an early adopter of geospatial technologies, the use in the private sector has grown substantially in the last decade. Technology and health care go hand in hand. The private healthcare sector is using these disruptive technologies to curtail soaring healthcare costs and improve quality while maintaining operational efficiency. The boon of technology ranges from those that improve the comfort of patients to those that save their lives.

Interestingly, among numerous technologies, geospatial technologies and IoT (Internet of Things) are becoming important tools for the modern healthcare sector to run more efficiently and effectively. GIS has been used for years by global health organizations like federal, state, and local public health agencies to support population health improvement efforts.

The private sector has traditionally used geospatial technologies in strategic planning and marketing. However, health reform has had a significant impact on the number of private sector organizations looking at the technology to support population health and community benefit initiatives. As the move to accountable care and value-based payments takes hold, providers and health plans are getting increasingly interested in applying geospatial technologies to assess risk based on geography and the populations that live there, reveal where the greatest need is, and prioritize areas for interventions.

Location-based intelligence is critical. Everything happens somewhere. Insight into 'where' makes all the difference in access to care, quality of care delivered, and the opportunity to achieve a positive healthcare outcome. There are many examples, from simple calculations of travel time to get to a clinic, to more unique uses such as setting up a geofence to keep individuals suffering from Alzheimer's disease safe. Newer technologies even make it possible for smart drones to deliver emergency resuscitation equipment to heart attack patients using spatial intelligence technology.[1]

Health geoinformatics is an emerging discipline that uses geospatial technologies to investigate health issues. GIS allows the analysis and display of complex information in a visually exciting format. It presents the ability to uncover patterns that might not have been initially apparent to the interpreter. Hence the current project would be taken up to assess the hospital marketing management by GIS spatial technology of patients attending a private health sector. The objectives are to assess the geographical distribution of patients attending a private health sector in the pre and present covid-19 era and to analyze the spatial density and socio-demographic information to identify the most relevant target market by using GIS spatial technology.

Methodology

The present study was done in the Mysuru District which is situated in the southern part of Karnataka state, India. It is an undulating tableland and has a strong lineage in Indian history. Mysuru District is sharing a border with Mandya District to the East, Kodagu District to the west, and Chamarajanagar District to the South. The Mysuru District covers an area of approximately 6854 square kilometers. It's in the 788 meters to 660 meters elevation range.[2]

The study design was a descriptive cross-sectional study conducted for three years from January 2018 to December 2020 among patients attending a tertiary care hospital situated in the Mysuru district of southern Karnataka, India. Purposive sampling was used to select the study participants. Before beginning the collection of data, the study details were explained to the hospital authorities and the department of medical records, and the necessary approvals were taken. The study population comprised of the patient's data without patient's personal information was collected from the medical records department of the hospital and the details regarding the sociodemographic factors (age, gender, address) and the details regarding the patient visit count, admission counts, department/clinic distribution of patient, address with pin code, diagnosis, hospitalization time, etc were obtained. The study subject's eligibility was decided by the discussions done with the staff of the medical records department, marketing, and hospital administrators. The participant's data that fulfilled the inclusion criteria like complete information on sociodemographic characteristics and the diagnosis were included. Those entries with incomplete data were excluded from the study. The source of the primary data was the medical records and the hospital information system.

Ethical clearance for the study was obtained from the Institutional ethics committee of the JSS Medical College, Mysuru with vide letter no JSSMC/IEC/ 150521/ 02 NCT/ 2021-22 Dated: 22.05.2021.

The statistical analysis was done by entering the data into Microsoft Excel 2013 spreadsheet and analyzed using SPSS Version 26.0 (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Quantitative variables like gender, religion, place of residence, etc. were represented using proportions. Association between quantitative variables was inferred using the Chi-

square test. A p-value less than 0.05 was considered statistically significant.

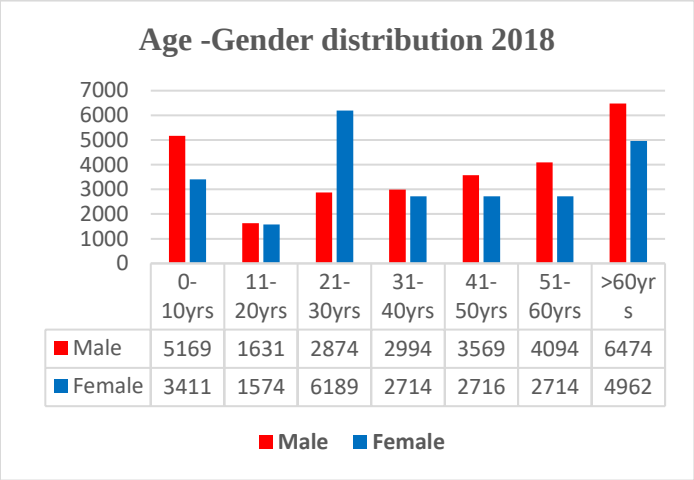
Geospatial analysis of the addresses of the study participants was done by Geocode Tool which helped to get latitudes & longitudes from the addresses in a Google Sheet which helped to display them on a map. Geocode uses Google's services to retrieve data and is optimized for address recognition. The latitude and longitude were entered in Microsoft Excel and converted into a CSV file (comma-separated values), they were exported into a free and open-source software version QGIS 3.16.3 "Hannover" a free and open-source geographic information system (released on 15.01.2021) to create maps.

Results

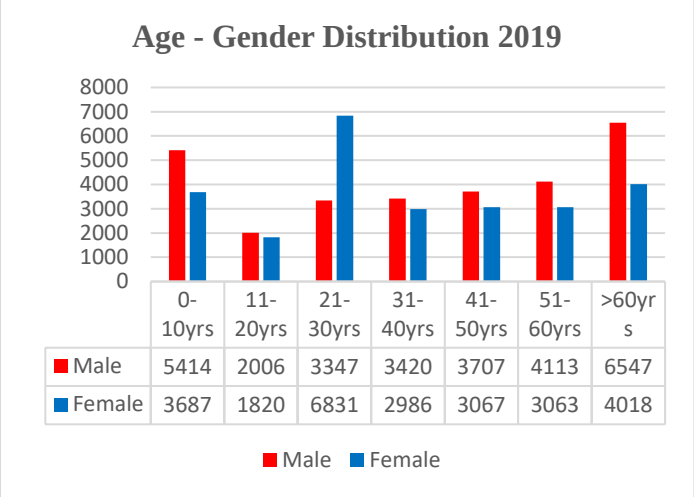
The present study was conducted in a tertiary care hospital catering to a population of southern Karnataka state. The Inpatient Department Patient details were collected from the medical records department and were studied. The mean age of the study participants in the year 2018 was 38.213+23.811 years. On average, 50,186 patients availed themselves of inpatient care in the year 2018. The majority of these patients were males (53.41%). Around 21% of the patients belonged to the age group of more than 60 years and 18% were between 21-30 years. It has been observed that the association between the age of the patient and gender was significant with a p-value <0.001.

In the year 2019 a total of 54027 patients were admitted and similar to 2018, the majority of them were males (52.85%) and belonged to the age group of more than 60 years (19.56%). The association between age group and gender was found to be statistically significant with a p-value <0.001. In the year 2020 during the Covid impacted period, a reducing number of patient admission was observed i.e., 35363 patients were admitted. Similar to the pre-Covid period, the majority of patients during the Covid affected period were also males (55.81%) and belonged to the age group of more than 60 years (20.58%). The association between gender and age group was found to be statistically significant with a p-value <0.001. **(Figure-01)**

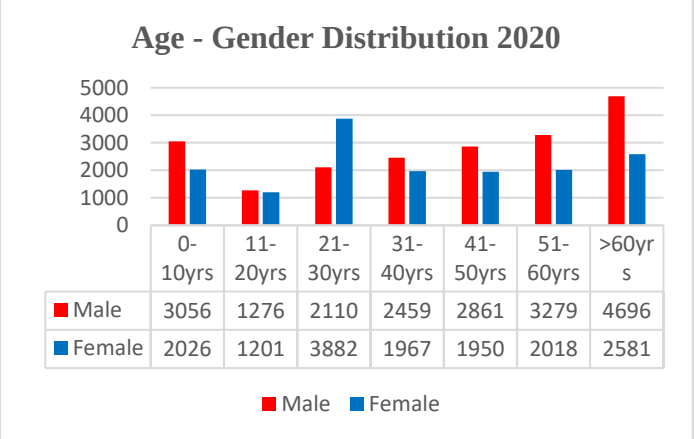
Figure-01: Distribution of the In-Patients based on Age Group and the Gender Admitted in the Period from 2018-2020



	0-10yrs	11-20yrs	21-30yrs	31-40yrs	41-50yrs	51-60yrs	>60yrs
Male	5169	1631	2874	2994	3569	4094	6474
Female	3411	1574	6189	2714	2716	2714	4962



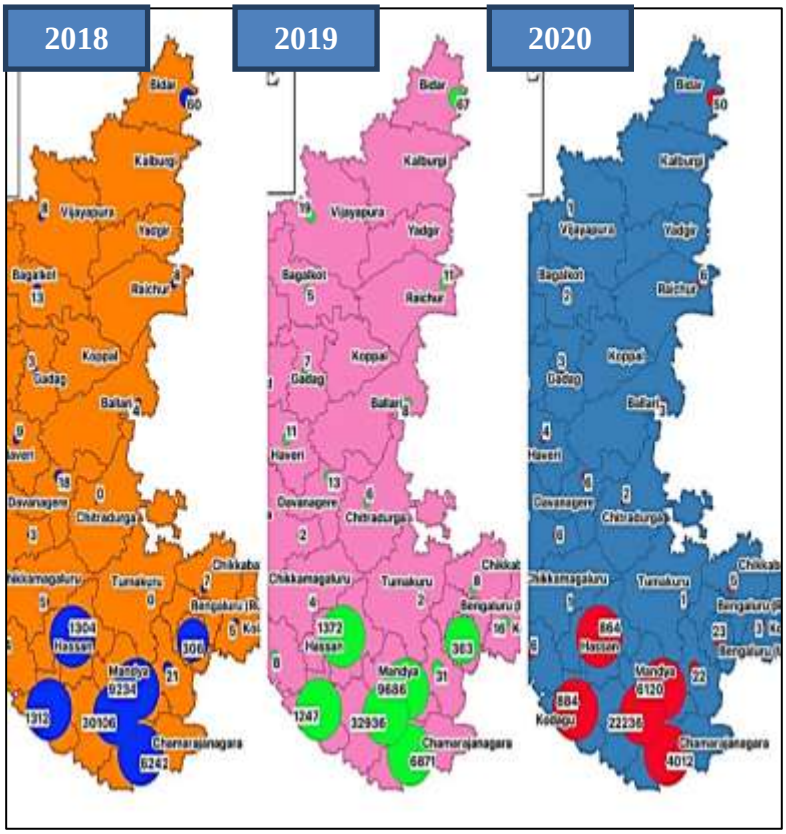
	0-10yrs	11-20yrs	21-30yrs	31-40yrs	41-50yrs	51-60yrs	>60yrs
Male	5414	2006	3347	3420	3707	4113	6547
Female	3687	1820	6831	2986	3067	3063	4018



	0-10yrs	11-20yrs	21-30yrs	31-40yrs	41-50yrs	51-60yrs	>60yrs
Male	3056	1276	2110	2459	2861	3279	4696
Female	2026	1201	3882	1967	1950	2018	2581

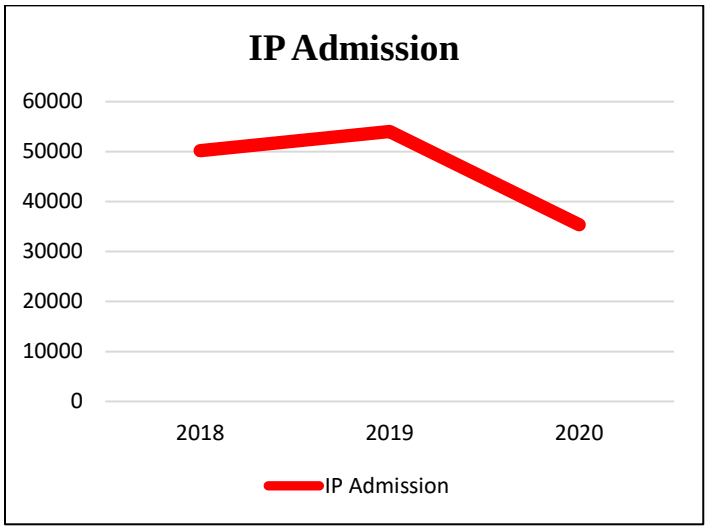
The in-patient geographical distribution of patients in a private health sector in the pre and present covid-19 era depicted a decreasing trend, especially from the surrounding areas, which could be observed in the GIS maps of Karnataka state. The patients vising the hospital from all over the state also have been reduced along with the neighboring districts. **(Figure-02)**

Figure-02: In-Patient Geographical Distribution of Patients in A Private Health Sector in The Pre and Present Covid-19 Era.



There was a change in the trend of In-Patient admission between the years 2018–2020. On comparing the total patients during the pre-Covid and covid impacted period, there was an average reduction of 32.14% cases (16744 patients) in the year 2020. **(Figure-03)**

Figure-03: Line Graph Depicting Change in Trend of In-Patient Admission Between the period 2018 – 2020



The Outpatient Department Patient details were collected from the medical records department and were studied. In the current study in the year 2018, it has been observed that the association of age and gender was statistically significant with a p-value <0.001.

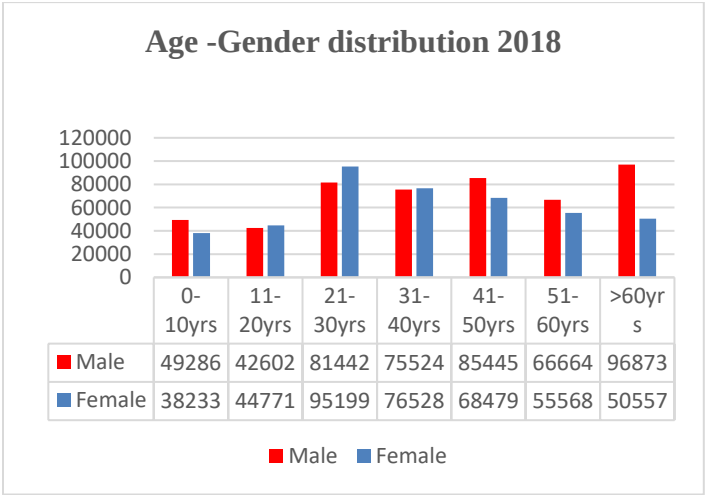
A total of 9,27,171 outpatients visits were recorded during the year 2018 out of which 83.20% of patients came for review while the remaining 16.80% were new registrations. The mean age of the patients was 38.642+20.189 years. The majority of patients were males (53.70%) and were married (73.01%). 19.05% of the study subjects belonged to the age group between 21-30 years while 16.60% were between 41-50 years. Out of the 36 various departments, the Medicine department (16.65%) and Surgery department (8.77%) had the maximum number of out-patient visits while the Human Genetics department (0.00021%) had the least number of cases.

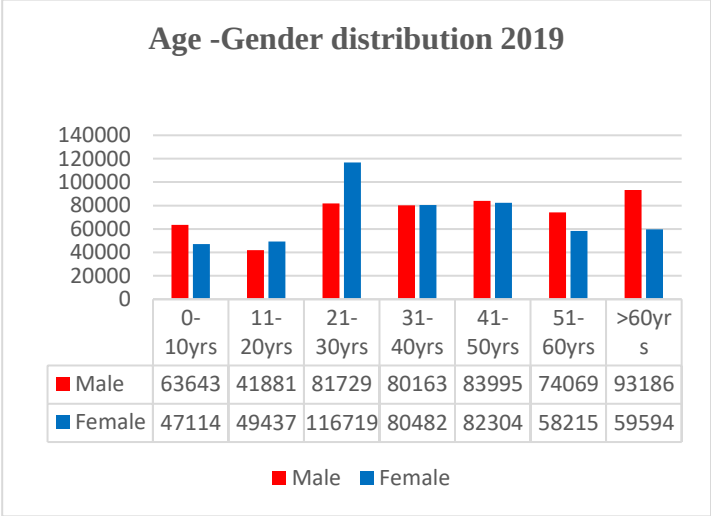
In the year 2019, around 10,12,531 patients attended the outpatient clinics of the hospital. More than 8 lakhs of these patients came for review check-ups and the majority of them were males (51.22%). Similar to 2018, most of the study subjects were married (71.46%) and belonged to the age group between 21-30 years (19.60%). Around 1.8 lakhs patients visited the medicine department, 78 thousand patients came to surgery OPD, 75 thousand patients for Obstetrics care and 74 thousand patients to the department of Orthopaedics during the 12 months. The Integrated Medicine department had the least OPD visits which were followed by Human Genetics and Interventional Neuro Radiology. In 2019, it was observed that the association between departments visited with gender was statistically significant with a p-value <0.001.

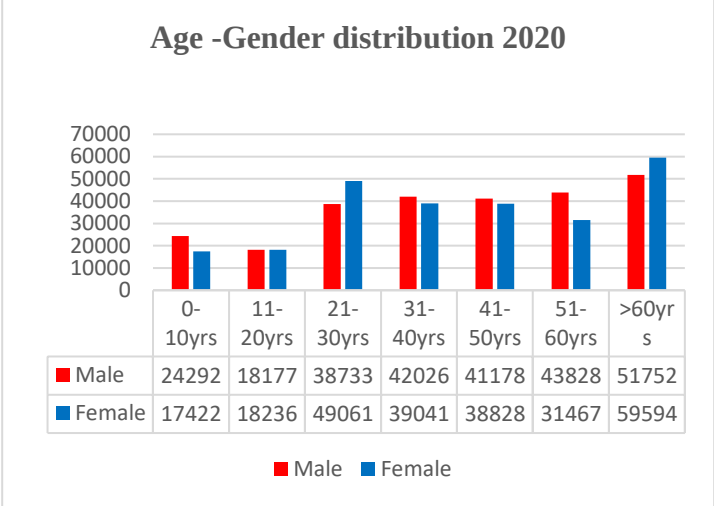
In the year 2020 due to Covid-19 infections, it was observed a massive reduction of patients compared to pre-Covid periods. Among the total 4,83,162 patients attending OPD clinics in the hospital, the majority of

them were males (53.81%) and came for review check-ups (72.35%). Most of the patients belonged to the age group of 21-30 years (18.17%) and around 38.88% of the patients were married. The maximum number of patients came for Medicine consultation (25%) followed by Emergency Medicine (7.30%) and Orthopaedics (7.05%). In 2020 it was observed that the association of gender and department visited was statistically significant with a p-value of <0.001. **(Figure-04)**

Figure-04: Distribution of the Out-Patients based on Age Group and the Gender

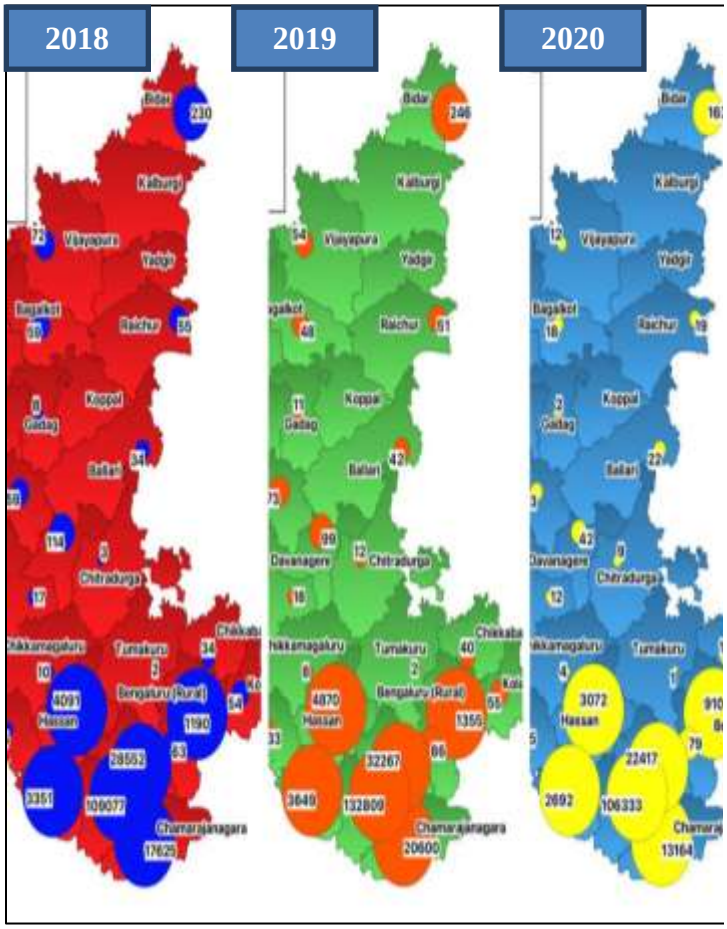






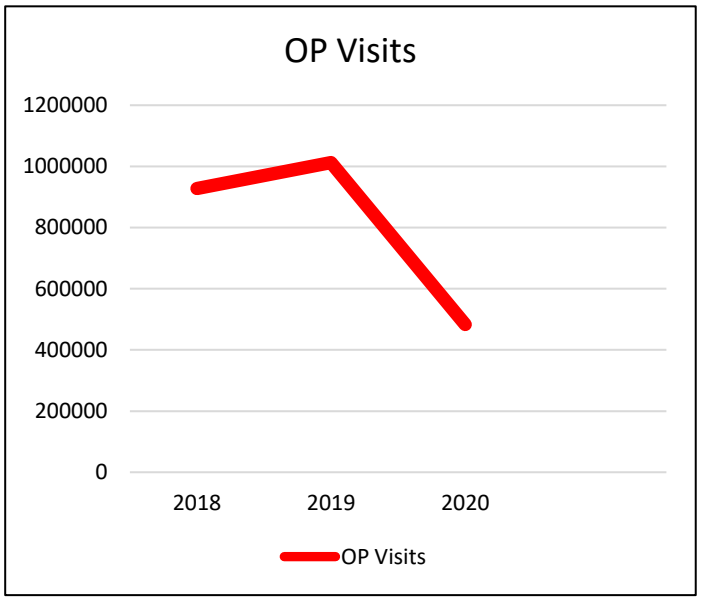
The out-patient geographical distribution of patients in a private health sector in the pre and present covid-19 era depicted a decreasing bubble size, which could be observed in the GIS maps showing the districts of Karnataka state. **(Figure-05)**

Figure-05: Outpatient geographical distribution of patients in a private health sector in the pre and present covid-19 era.



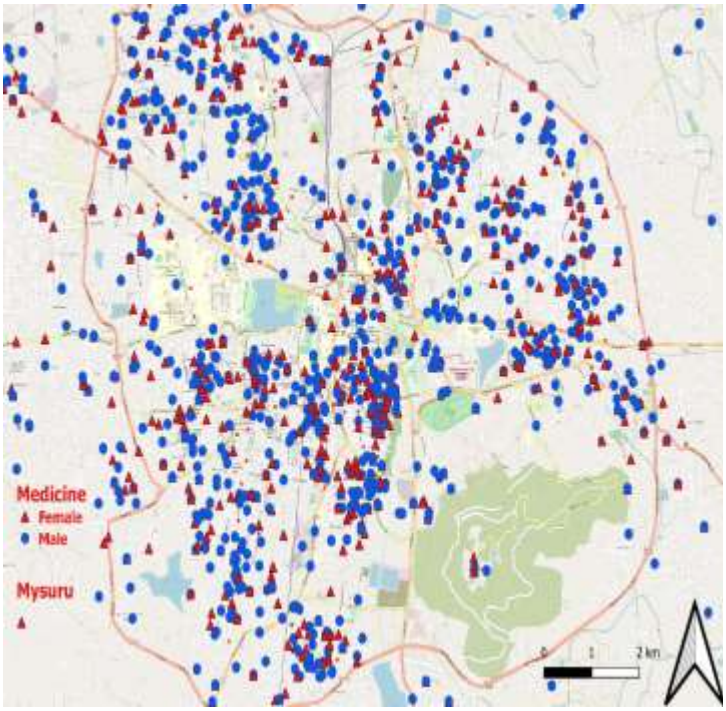
The Covid-19 impacted period of 2020 saw a massive fall of patients visiting the outpatient department from 9,27,171 in 2018 and 10,12,545 in 2010 to 4,83,162, i.e., almost 49.89% reduction which is depicted in the line diagram. **(Figure-06)**

Figure-06: Line graph depicting a change in the trend of Out-Patient cases between 2018 – 2020



The geographical distribution of in-patients according to clinical departments in the hospital is showing the areas from where the patients are coming from and the grey areas where the reach of the hospital could be extended to enhance the utilization of the services from the health care. The GIS maps showed that many super-specialty departments could enhance their reach and coverage and services. **(Figure-07)**

Figure-07: Geographical Distribution of Patients According to Clinical Department in the Hospital



Discussion

The present study with the application of GIS will help the hospital in identifying and prioritizing the resources for a marketing team to target the low turnover areas catered by the hospital thus improving the performance of the team.

The hospital could visualize and capture insight into where demand was coming from to perform predictive analytics. In hospitals, GIS gained acceptance as an essential analytical tool for strategic planning and marketing. Analytical studies of patient origins and resident destinations, health facility site locating, and market demographic analysis headed up the list of most useful applications.[3] Customers of private hospitals consist of people who are living in their vicinity or patients prefer closer health care centers which are more easily reached" hypothesis was asked to be substantiated. In density maps, it can be seen that patient visit density increased around and inversely decreased away from the hospital. Additionally, due to easy access, the visit density also increased along the way routes.

GIS has become a critical tool for state and local health departments and has allowed them to extend the concept of geography into many aspects of their chronic disease programs. These responses reveal the extent to which health departments are using maps and spatial analyses to 1) communicate the burden of disease 2) inform decisions about resource allocation, policy, and priority communities for intervention efforts 3) develop culturally competent programs and 4) assist with program planning, monitoring, and evaluation. The continued and enhanced application of GIS to chronic disease surveillance, prevention, and treatment priorities can provide valuable benefits both to health departments and to the communities

they serve. The hard part of taking advantage of this flood of geospatial information will be making sense of it, turning raw data into understandable information." [4] Geography plays a major role in understanding the dynamics of health, and the causes and spread of disease.[5] The classic public health triad composed of man, agent/vehicle and environment emphasizes the importance of geographic location (environment or space where we live) in health and disease. Interactions within this triad can also change with time. Today's health planners aim at developing health policy and services that address geographical and social inequalities in health and therefore should benefit from evidence-based approaches that can be used to investigate spatial aspects of health policy and practice and evaluate geographical equity (or inequity) in health service provision.[6] The tools to achieve this goal should be accessible and usable by mainstream practitioners, transparently embedded into routine workflows, and seamlessly incorporated into existing busy work environments.[7] GIS is a potentially powerful resource for community health for many reasons including their ability to integrate data from disparate sources to produce new information, and their inherent visualization (mapping) functions, which can promote creative problem solving and sound decisions with lasting, positive impacts on people's lives.[8],[9] According to Koch and Tom [10] and Geraghty, the first spatial health map of plague disease spread was produced in Bari, Italy, in 1694. GIS is an effective tool for dealing with issues of healthcare services, especially those related to the service location.[11] The WHO and the World Bank [12] emphasized that nearly half the world's population faces difficulty in accessing healthcare.

The geographical location analytics solution provides the hotspot analysis and also provides a set of Key Performance Indicator (KPI) reporting tools, giving managers a dramatically improved understanding of the status of demand in the hospital by enabling them to break down the parameters and strategize the marketing management of the hospital in priority setting.

The team could be able to identify the areas from where the hospital is getting the patients and what kind of patients are coming from the particular areas. This will help to relocate the marketing resources to improve the low turnover rate in the hospital catering areas.

GIS enables hospitals and health systems to develop location-based population health strategies and insight that goes deeper than simply what happens inside of a hospital or doctor's office.

The healthcare providers can utilize GIS as the platform for integrating and analyzing clinical data — alongside environmental, behavioral and socio-economic data, to gain a more complete, holistic view and understanding of their patient's needs, the non-clinical factors that influence poor health outcomes and places that should be targeted with community-based interventions.

Limitations

The limitation of using hospital records is the lack of data on the underlying causes of disease in people's living environments.

While inpatient records can yield insight into the prevalence and distribution of health problems with known environmental causes or contributions, they do not provide information on environmental or social factors (e.g., the gender division of labour) that render some groups (e.g., women and children) more at risk than others. This point is important because it reaffirms the need for multi-level approaches to understanding the determinants of health in urban environments like Behavioural and environmental fields.

The geographic location of the data was calculated area-wise to protect the identity of the individual patients, thus a more accurate location couldn't be used.

We could only analyze the last three years' data in this project, the greater number of years of data could have given still a broader picture.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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AUTHORS

First Author – Dr Sunil Kumar D, Professor and Head of the Department, Department of Community Medicine, JSS Medical College, JSS Academy of Higher Education and Research.
Second Author – Dr Sathish Raju Nilakantam, Senior Resident and Clinical Administrator, Department of Hospital Administration, JSS Medical College, JSS Academy of Higher Education and Research.
Third Author – Dr Deepak Anil, Post Graduate, Department of Community Medicine, JSS Medical College, JSS Academy of Higher Education and Research.
Fourth Author- Dr M R Narayana Murthy, Professor, Department of Community Medicine, JSS Medical College, JSS Academy of Higher Education and Research.

Correspondence Author – Dr Deepak Anil
Department of Community Medicine, JSS Medical College, JSS Academy of Higher Education and Research, Sri Shivarathreeshwara Nagara, Mysuru- 570015, Karnataka, India.
Email id- deepakanil7@gmail.com
Ph no: +918921448204